PRACTICAL RESERVOIR PERFORMANCE ANALYSIS & REVIEW USING OFM

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Legacy Reserves Operating, LP

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WHAT IS OFM??

- **Oil Field Manager**
- Licensed software from Schlumberger
- Primary functions:
  - Reservoir surveillance
  - Production surveillance
  - Production forecasting
WHAT IS OFM??

• Database Interface (MS Access)

• Additional functions:
  – Log displays & cross sections
  – Wellbore diagrams
RESERVOIR SURVEILLANCE

• Identify aquifer influx mechanism/direction
• Identify dominant fluid flow direction/well-to-well communication

PRODUCTION/INJECTION SURVEILLANCE

• Production plots
• Hall plots
AQUIFER INFLUX MECHANISM/DIRECTION

Example 1
Fourbear
AQUIFER INFLUX MECHANISM/DIRECTION

Example 1
Fourbear
AQUIFER INFLUX MECHANISM/DIRECTION

Example 1
Fourbear

Date: 1/1/1960
Fourbear Structure Unit

[Diagram showing the Fourbear Structure Unit with various FB numbers and symbols indicating oil cut and water cut percentages.]

LEGACY RESERVES

[Logo of the Oil Recovery Institute]
AQUIFER INFLUX MECHANISM/DIRECTION

Example 1
Fourbear
AQUIFER INFLUX MECHANISM/DIRECTION

Example 1
Fourbear

Date: 1/1/1967
Fourbear Structure Unit

Oil Cut (%)
Water Cut (%)

LEGACY RESERVES
Recovery Institute
AQUIFER INFLUX MECHANISM/DIRECTION

Example 2
Quealy Dome (Dakota)
AQUIFER INFLUX MECHANISM/DIRECTION

Example 2
Quealy Dome
(Dakota)

Date: 1/1/1942

Oil Cut ( % )
Water Cut ( % )
AQUIFER INFLUX MECHANISM/DIRECTION

Example 2
Quealy Dome
(Dakota)
Example 2
Quealy Dome (Dakota)

AQUIFER INFLUX MECHANISM/DIRECTION
AQUIFER INFLUX MECHANISM/DIRECTION

Example 2
Quealy Dome (Dakota)

Date: 1/1/1953

Oil Cut ( % )
Water Cut ( % )
Example 2
Quealy Dome (Dakota)

AQUIFER INFLUX MECHANISM/DIRECTION
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek Waterflood
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek Waterflood
Bubble Map of Water Rates (Inj & Prod)
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek Waterflood

Bubble Map of Water Rates (Inj & Prod)

4 Yrs After Unitization
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek Waterflood

Bubble Map of Water Rates (Inj & Prod)

13 Yrs After Unitization
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek Waterflood

Bubble Map of Water Rates (Inj & Prod)

24 Yrs After Unitization
Example 3
Kirby Creek
Waterflood
Bubble Map
of Water Rates
(Inj & Prod)

DOMINANT FLUID FLOW DIRECTION

27+ Yrs After Unitization

Date: 3/1/1996
Kirby Creek Unit

Water Rate (Cal Day) (bbl/d)
W. Inj Rate (Cal Day) (bbl/d)
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek
Waterflood

40 Yrs After Unitization

Bubble Map
of Water Rates
(Inj & Prod)
DOMINANT FLUID FLOW DIRECTION

Example 3
Kirby Creek Waterflood
Bubble Map of Water Cum’s (Inj & Prod)
DOMINANT FLUID FLOW DIRECTION

Example 4
N2 Flood
in OK
DOMINANT FLUID FLOW DIRECTION

Example 4
N2 Flood in OK

Bubble Map of Gas Rates (Inj & Prod)

Gas Rate (CalDay) (Mcf/d)
Gas Inj Rate (CalDay) (Mcf/d)
DOMINANT FLUID FLOW DIRECTION

Example 4
N2 Flood
in OK

Bubble Map
of Gas Rates
(Inj & Prod)
DOMINANT FLUID FLOW DIRECTION

Example 4
N2 Flood in OK

Bubble Map of N2 Cum’s (Inj & Prod)
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 5 (B-031282)
Reservoir Name: PHOSPHORIA
Spud: 07/20/1940
Plug: *

Cumulative Oil Produced: 321.01 Mbbl
Cumulative Gas Produced: 25.82 MMcf
Cumulative Water Produced: 1565.21 Mbbl

Oil Rate (Cal Day) (bbl/d)
Water Rate (Cal Day) (bbl/d)
Water Cut (%)
Oil Cut (%)

Clean out & Acidize
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK 9 (UNIT B-041616)
Reservoir Name: PHOSPHORIA
Spud: 06/15/1984
Plug: *

Cumulative Oil Produced: 106.89 Mbbl
Cumulative Gas Produced: 34.84 MMcf
Cumulative Water Produced: 321.66 Mbbl

Missing water production data
Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK 11 (64-12195)
Reservoir Name: PHOSPHORIA
Spud: 03/09/1984
Plug: *

Cumulative Oil Produced: 38.22 Mbbl
Cumulative Gas Produced: 11.18 MMcf
Cumulative Water Produced: 203.72 Mbbl
Spud: 03/09/1984
Plug: *

PRODUCTION PLOTS

Oil Rate (Cal Day) (bbl/d)
Water Rate (Cal Day) (bbl/d)
Water Cut (%)
Oil Cut (%)

Acidize
CTI
Tbg Leaks
Acidize & Replace with IC tubing
RTP

Missing water production data
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 15
Reservoir Name: PHOSPHORIA
Spud: 10/21/1997
Plug: *

Cumulative Oil Produced: 72.10 Mbbl
Cumulative Gas Produced: 19.88 MMcf
Cumulative Water Produced: 29.54 Mbbl

 Missing water production data
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 16
Reservoir Name: PHOSPHORIA
Spud: 08/14/1997
Plug: *

- Cumulative Oil Produced: 42.95 Mbbl
- Cumulative Gas Produced: 13.81 MMcf
- Cumulative Water Produced: 278.14 Mbbl

Oil Rate (Cal Day) (bbl/d)
Water Rate (Cal Day) (bbl/d)
Water Cut (%)
Oil Cut (%)

Acidize & Frac

Missing water production data
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 17
Reservoir Name: PHOSPHORIA
Spud: 12/28/1993
Plug: *

Missing water production data
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 19
Reservoir Name: PHOSPHORIA
Spud: 10/13/1994
Plug: *

- Oil Rate (Cal Day) (bbl/d)
- Water Rate (Cal Day) (bbl/d)
- Water Cut (%)
- Oil Cut (%)

Cumulative Oil Produced: 57.08 Mbbl
Cumulative Gas Produced: 22.56 MMcf
Cumulative Water Produced: 1480.61 Mbbl
Spud: 10/13/1994
Plug: *
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 23
Reservoir Name: PHOSPHORIA
Spud: 02/18/1998
Plug: *

Cumulative Oil Produced: 31.00 Mbbl
Cumulative Gas Produced: 9.62 MMcf
Cumulative Water Produced: 444.47 Mbbl

Oil Rate (Cal Day) (bbl/d)
Water Rate (Cal Day) (bbl/d)
Water Cut (%)
Oil Cut (%)

Enhanced Oil Recovery Institute
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 24
Reservoir Name: PHOSPHORIA
Spud: 12/26/1997
Plug: *

Cumulative Oil Produced: 28.30 Mbbl
Cumulative Gas Produced: 11.94 MMcf
Cumulative Water Produced: 181.37 Mbbl

Oil Rate (Cal Day) (bbl/d)
Water Rate (Cal Day) (bbl/d)
Water Cut (%)
Oil Cut (%)

Missing water production data
Legacy Reserves Operating LP
Field Name: KIRBY CREEK
KIRBY CREEK UNIT 25
Reservoir Name: PHOSPHORIA
Spud: 01/09/1998
Plug: *

Cumulative Oil Produced: 60.36 Mbbl
Cumulative Gas Produced: 24.33 MMcf
Cumulative Water Produced: 662.98 Mbbl
Spud: 01/09/1998
Plug: *
Legacy Reserves Operating LP

Field Name: KIRBY CREEK

KIRBY CREEK UNIT 28

Reservoir Name: PHOSPHORIA

Spud: 01/22/1998

Plug: *

Missing water production data
PRODUCTION PLOTS

Legacy Reserves Operating LP
Field Name: MURPHY DOME
SHAD 10
Reservoir Name: TENSLEEP
Spud: 08/21/1954
Plug: *

Cumulative Oil Produced: 540.38 Mbbl
Cumulative Water Produced: 35193.86 Mbbl
Cumulative Gas Produced: 0.00 MMcf

Polymer Injection History:
1. Initial Injection
2. Polymer Injection
3. Polymer Suspension

Enhanced Oil Recovery Institute
Legacy Reserves Operating LP.
Field Name: Edsel
Reservoir Name: MINNELUSA 'B'
Spud: 05/30/1982
Plug: *

EDSEL UNIT 7

Cumulative Oil Produced: 11.46 Mmbbl
Cumulative Gas Produced: 0.71 MMcf
Cumulative Water Produced: 21.24 Mmbbl
Cumulative Water Injected: 21020.12 Mmbbl

Hall Plot

Cumulative Water Injected (Mmbbl)
Cumulative Pressure (PSI*Days)
HALL PLOTS – MONITOR INJECTIVITY

Legacy Reserves Operating LP.
Field Name: Lily
Reservoir Name: MINNELUSA 'A'
Spud: 10/31/1984
Plug: *

LILY UNIT 3

Cumulative Oil Produced: 536.84 Mbbl
Cumulative Gas Produced: 0.00 MMcf
Cumulative Water Produced: 1788.92 Mbbl
Cumulative Water Injected: 2278.49 Mbbl

Hall Plot

Cumulative Water Injected (Mbbl) vs. Cumulative Pressure (PSI*Days)

Legend:
- Black line: Cumulative Pressure (PSI*Days) - Lily U. 3
ADDITIONAL TOOLS IN THE BOX

• Pattern analysis
• Production Forecasting
• Nodal analysis
• Material Balance